



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CHEMISTRY

0620/33

Paper 3 (Extended)

October/November 2013

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 12.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **12** printed pages.



1 Zirconium (Zr) is a metal in Period 5. Its main oxidation state is +4.

(a) The following are all zirconium atoms: ${}_{40}^{90}\text{Zr}$, ${}_{40}^{91}\text{Zr}$ and ${}_{40}^{92}\text{Zr}$.

In terms of numbers of electrons, neutrons and protons, how are these three atoms the same and how are they different?

They are the same because

.....

They are different because

..... [3]

(b) Containers for fuel rods in nuclear reactors are made of zirconium.
Nuclear reactors are used to produce energy and to make radioactive isotopes.

(i) Which isotope of a different element is used as a fuel in nuclear reactors?

..... [1]

(ii) State one medical and one industrial use of radioactive isotopes.

.....

..... [2]

(iii) Above 900 °C, zirconium reacts with water to form zirconium(IV) oxide, ZrO_2 , and hydrogen. Write an equation for this reaction.

..... [2]

(iv) In a nuclear accident, water may come in contact with very hot zirconium.
Explain why the presence of hydrogen inside the reactor greatly increases the danger of the accident.

..... [1]

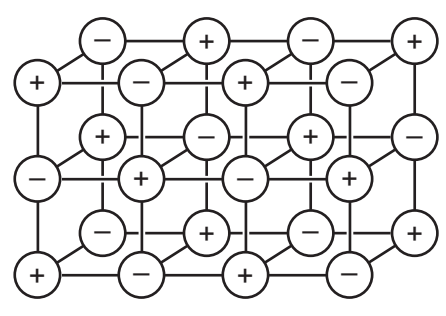
(c) It is possible to determine whether zirconium(IV) oxide is acidic, neutral, basic or amphoteric using an acid and an alkali. Complete the table of possible results. If the oxide is predicted to react write 'R', if it is predicted not to react write 'NR'.

if the oxide is	predicted result with hydrochloric acid	predicted result with aqueous sodium hydroxide
acidic		
neutral		
basic		
amphoteric		

[4]

[Total: 13]

2 (a) The diagram shows the lattice of a typical ionic compound.



(i) Explain the term *ionic lattice*.

.....
 [2]

(ii) In this lattice, the ratio of positive ions to negative ions is 1:1.
 In the lattice of a different ionic compound, the ratio of positive ions to negative ions is 1:2.
 Suggest why this ratio varies in different ionic compounds.

..... [1]

(iii) Give **three** physical properties of ionic compounds.

.....

 [3]

(b) Strontium oxide is an ionic compound. Draw a diagram which shows its formula, the charges on the ions and the arrangement of the **valency** electrons around the negative ion.

The electron distribution of a strontium atom is 2 + 8 + 18 + 8 + 2.

Use o to represent an electron from a strontium atom.

Use x to represent an electron from an oxygen atom.

[3]

[Total: 9]

3 The main uses of zinc are preventing steel from rusting and making alloys.

(a) The main ore of zinc is zinc blende. Zinc blende consists mainly of zinc sulfide, ZnS. There are two major methods of extracting zinc from its ore. They are the direct reduction of zinc oxide to zinc and by electrolysis. In both methods, zinc oxide is made from the zinc sulfide in the ore.

(i) How is zinc oxide made from zinc sulfide?

.....
..... [1]

(ii) Write an equation for the reaction used to reduce zinc oxide to zinc.

..... [1]

(b) In the electrolytic method, zinc oxide reacts with sulfuric acid to form impure aqueous zinc sulfate. This solution contains Ni²⁺, Co²⁺ and Cu²⁺ ions as impurities.

(i) Write the equation for the reaction between zinc oxide and sulfuric acid.

..... [1]

(ii) Nickel, cobalt and copper are all less reactive than zinc. Explain why the addition of zinc powder removes these ions from the solution.

.....
..... [2]

(c) The solution of zinc sulfate is electrolysed using inert electrodes. This electrolysis is similar to that of copper(II) sulfate with inert electrodes.

(i) Write the equation for the reaction at the negative electrode (cathode).

..... [1]

(ii) Complete the equation for the reaction at the positive electrode (anode).



(iii) The electrolyte changes from zinc sulfate to

..... [1]

(d) (i) Brass is an alloy of copper and zinc. Suggest **two** reasons why brass is often used in preference to copper.

.....
..... [2]

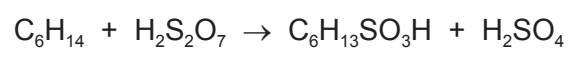
(ii) Sacrificial protection is a method of rust prevention. Explain in terms of electron transfer why steel, which is in electrical contact with zinc, does not rust.

.....
.....
.....
..... [4]

[Total: 15]

4 Sulfuric acid is a strong acid. Hexanesulfonic acid is also a strong acid. It has similar properties to sulfuric acid.

(a) Sulfonic acids are made from alkanes and oleum, H₂S₂O₇.



(i) Describe how oleum is made from sulfur by the Contact process. Give equations and reaction conditions.

.....
.....
.....
.....
.....
.....
.....
.....
..... [6]

(ii) How is concentrated sulfuric acid made from oleum?

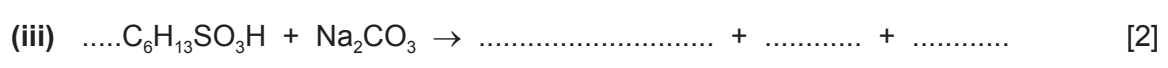
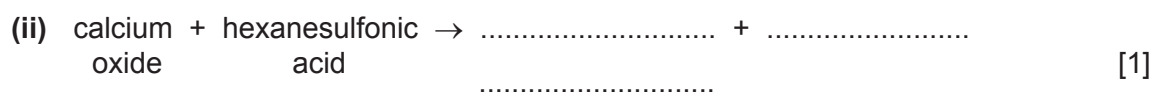
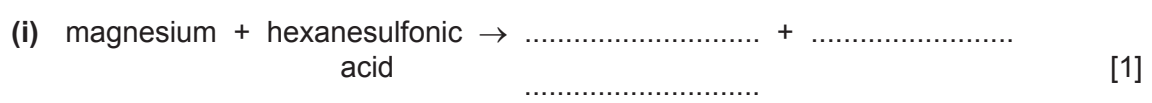
..... [1]

(b) The formula of the hexanesulfonate ion is C₆H₁₃SO₃⁻.

The formula of the barium ion is Ba²⁺. What is the formula of barium hexanesulfonate?

..... [1]

(c) Complete the following equations.



(d) (i) Sulfuric acid is a strong acid.
You are given aqueous sulfuric acid, concentration 0.1 mol/dm^3 , and aqueous
hexanesulfonic acid, concentration 0.2 mol/dm^3 . Describe how you could show that
hexanesulfonic acid is also a strong acid.

.....
..... [2]

(ii) Deduce why, for a fair comparison, the two acid solutions must have different
concentrations.

.....
..... [1]

(iii) Explain the terms *strong acid* and *weak acid*.

.....
.....
..... [2]

[Total: 17]

- 5 Domestic rubbish is disposed of in landfill sites. Rubbish could include the following items:

item of rubbish	approximate time for item to break down
newspaper	one month
cotton rag	six months
woollen glove	one year
aluminium container	up to 500 years
styrofoam cup	1000 years

- (a) Explain why aluminium, a reactive metal, takes so long to corrode.

..... [1]

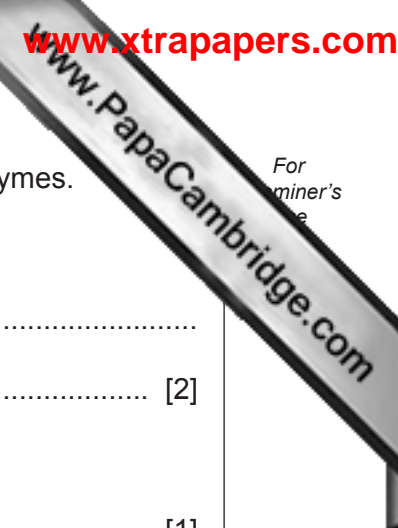
- (b) Both paper and cotton are complex carbohydrates. They can be hydrolysed to simple sugars such as glucose.

The formula of glucose can be represented as:



Draw the structural formula of a complex carbohydrate, such as cotton. Include at least **two** glucose units.

[2]



For
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e

(c) Wool is a protein. It can be hydrolysed to a mixture of monomers by enzymes.

(i) What are enzymes?

.....
..... [2]

(ii) Name another substance which can hydrolyse proteins.

..... [1]

(iii) What type of compound are the monomers formed by the hydrolysis of proteins?

..... [1]

(iv) Which technique could be used to identify the individual monomers in the mixture?

..... [1]

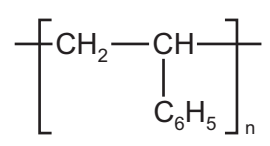
(v) Proteins contain the amide linkage. Name a synthetic macromolecule which contains the same linkage.

..... [1]

(d) (i) What is the scientific term used to describe polymers which do not break down in landfill sites?

..... [1]

(ii) Styrofoam is poly(phenylethene). It is an addition polymer. Its structural formula is given below. Deduce the structural formula of the monomer, phenylethene.



[1]

[Total: 11]

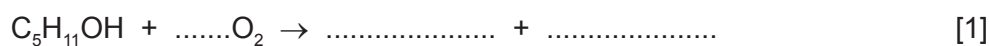
- 6 The alcohols form a homologous series. The first five members are given in the table

(a)

alcohol	formula	heat of combustion in kJ/mol
methanol	CH ₃ OH	730
ethanol	CH ₃ -CH ₂ -OH	1380
propan-1-ol		
butan-1-ol	CH ₃ -CH ₂ -CH ₂ -CH ₂ -OH	2680
pentan-1-ol	CH ₃ -CH ₂ -CH ₂ -CH ₂ -CH ₂ -OH	3350

(i) Complete the table. [2]

(ii) Complete the equation for the combustion of pentan-1-ol in excess oxygen.

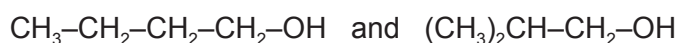


(b) State **three** characteristics of a homologous series other than the variation of physical properties down the series.

.....

 [3]

(c) The following alcohols are isomers.



(i) Explain why they are isomers.

.....

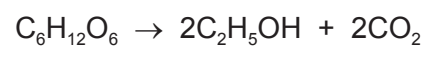
 [2]

(ii) Draw the structural formula of another isomer of the above alcohols.

[1]

(d) Alcohols can be made by fermentation and from petroleum.

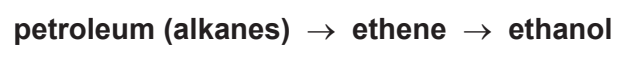
(i) Ethanol is made from sugars by fermentation.



The mass of one mole of glucose, $C_6H_{12}O_6$, is 180 g.
Calculate the maximum mass of ethanol which could be obtained from 72 g of glucose.

.....
.....
.....
..... [3]

(ii) Describe how ethanol is made from petroleum.



.....
.....
.....
..... [3]

[Total: 15]

DATA SHEET
The Periodic Table of the Elements

		Group																				
I	II	III	IV	V	VI	VII	0															
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10														
23 Na Sodium 11	24 Mg Magnesium 12	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18															
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36					
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	101 Ru Ruthenium 44	101 Rh Rhodium 45	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54					
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	209 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86						
87 Fr Francium	88 Ra Radium	89 Ac Actinium																				
				140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71							
				232 Th Thorium 90	238 Pa Protactinium 91	238 U Uranium 92	238 Np Neptunium 93	238 Pu Plutonium 94	238 Am Americium 95	238 Cm Curium 96	238 Bk Berkelium 97	238 Cf Californium 98	238 Es Einsteinium 99	238 Fm Fermium 100	238 Md Mendelevium 101	238 No Nobelium 102	238 Lr Lawrencium 103					

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

*58-71 Lanthanoid series
†90-103 Actinoid series

	a	= relative atomic mass
Key	X	= atomic symbol
	b	= proton (atomic) number

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